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ON MY MIND

GEOINT Saves Lives—Global Humanitarian Support and Disaster Relief

Washingtonian magazine, in its November 2009 issue, showcased NGA as one of the 50 great places to work in the Washington, D.C. area and one of five federal agencies featured. We were recognized for, among other things, our challenging work and mission and how much of a difference we are making. One example of our mission responsibilities is our support to global humanitarian and disaster relief operations.

When manmade or natural disasters strike, geospatial intelligence (GEOINT) saves lives. NGA delivers detailed maps and analysis of damage, routes and infrastructure—whatever crisis teams need to get supplies and relief to where they are needed and to minimize loss of life. By providing a unique perspective to understanding the Earth, GEOINT provides the situational awareness required to expedite the disaster-relief and humanitarian-assistance mission.

NGA reports on a range of disasters and other crises, from earthquakes and hurricanes to the movement of refugees and internally displaced persons. GEOINT provides the context from beginning to end—meaning that GEOINT guides meteorological forecasts, identifies physical changes to the Earth and aids in understanding and responding in the aftermath of catastrophic events. We identify, collect, use and share relevant GEOINT data. If a disaster appears imminent, we gather the specific data and information necessary to support partner organizations—like the Federal Emergency Management Agency (FEMA), the U.S. Agency for International Development, the Department of State and the Department of Homeland Security—that may become involved in the relief effort. Once a crisis occurs, we provide that information to decision makers to help them determine the size and scope of the disaster and guide them in managing their response.

The support provided during Cyclone Sidr is one example of NGA at work. The Category 5 storm struck Bangladesh, killing 3,400 and displacing millions. Our personnel at the U.S. Pacific Command and in St. Louis provided commercial imagery, situational awareness products, damage assessments, reports and briefing materials to command and operational units on an almost continuous basis for a month. We also supplied GEOINT products to the U.S. Navy and Marine Corps units providing direct relief assistance. Although many lives were lost, the careful planning and constant GEOINT updates kept the losses far below the 140,000 deaths from a similar storm in 1991.

Humanitarian operations following Tropical Storm Nargis in Burma, Cyclone Ivan in Madagascar, Cyclone Jokwe in Mozambique and flooding in Costa Rica, Nicaragua, Honduras and Guatemala offer other examples of NGA's rapid insertion of GEOINT in crisis situations. During wildfires in Australia, NGA shared imagery, damage assessment data, critical infrastructure analysis and computer modeling with the Defense Imagery and Geospatial Organization and other Australian authorities to aid them in mounting their response.

In Darfur, NGA was one of the first organizations to uncover evidence of widespread destruction. Our analysis provided U.S. civilian agencies, including the Department of State, with some of the earliest indications of the magnitude of the humanitarian crisis in the region.

In September 2009, when a magnitude-8.0 earthquake struck the Samoan islands, spawning tsunamis with waves of up to 20 feet, NGA stepped in to provide GEOINT support to our mission partners in Samoa and American Samoa.

During the crisis in Samoa, NGA analysts in the region, and our reach-back teams stateside, delivered initial damage assessments for the tsunami to Australia and New Zealand, the lead countries delivering operational relief on site. NGA also produced continuing assessments and identified key infrastructure locations.

After President Obama issued a disaster declaration for American Samoa, FEMA asked NGA to provide damage-assessment data and information to support relief efforts. NGA disseminated pre- and post-earthquake and pre-tsunami commercial imagery to FEMA and other NGA mission partners working the crisis and created graphics depicting infrastructure sites in some of the harder-hit areas. Through wide dissemination of information and data, NGA set out to enable first responders and other relief workers to move forward with a common operating picture so that they could do their jobs more quickly and effectively.

When a crisis occurs, GEOINT provides a common foundation to guide the efforts of all participants in the humanitarian-assistance and disaster-relief enterprise. NGA, the National System for Geospatial Intelligence, and our Allied partners are committed to providing that crucial, time-sensitive GEOINT whenever and wherever it is necessary.

ROBERT B. MURRETT
Vice Admiral, USN
Director

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ON THE COVER

People and nations the world over find themselves in need. Catastrophes, natural or manmade, trouble the Earth and stretch its resources. Situated best to understand the Earth, NGA contributes invaluable to disaster mitigation and the relief of suffering populations. Preparing whenever possible and responding urgently, the agency routinely employs its geospatial expertise to aid those in need however it can. Predicting floods before they start or assisting in the aftermath, aiding the delivery of relief shipments or building anew, helping care for the land or increasing its bounty, NGA remains committed to humanitarian missions around the globe. Cover design by Anika McMillon.

More to the Story?

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LETTER TO OUR READERS

The Global Humanitarian Enterprise

Intelligence plays an invaluable role in mitigating humanitarian crises across the globe. NGA's unique geospatial intelligence (GEOINT) mission continues to aid policy makers in making decisions that help curb the instability associated with these crises. This agency is committed to using its resources and expertise to understand the humanitarian and environmental issues of our times.

NGA and GEOINT are particularly well-equipped to engage humanitarian mission partners. GEOINT provides unique information required by those who prepare for and respond to disasters or other strains on people, land or resources. This issue of the Pathfinder explores several examples of this engagement.

In one example, the U.S. Department of Agriculture teamed up with NGA to forestall famine in Iraq. The agency then went a step further to provide irrigation and agriculture assessments for Iraq's future. In the same manner, GEOINT monitoring of water levels is helping to restore Iraq's southeastern marshes, almost destroyed by the Baathist government, and to predict flooding in Afghanistan.

Deforestation remains a significant problem in many areas of the world. NGA serves with an interagency consortium to identify land cover changes in Cambodia that could lead to more serious consequences. In the troubled Darfur region, GEOINT has kept a watch. In Georgia, it has allowed relief vessels to dock with essential aid.

The international community has not benefitted alone from NGA's efforts. The agency's work surrounding Hurricane Ike underscores GEOINT's preparations and responses to domestic crises. In similar fashion, the design of the agency's New Campus East demonstrates NGA's dedication to being a wise environmental steward.

NGA serves best when guided by a global vision. This agency regards the global humanitarian enterprise as vitally important. NGA's commitment to this mission reflects both the country's historic idealism and its ongoing assistance to those in need. The next issue of Pathfinder will illustrate the value of NGA's extensive deployer program to that global vision and the GEOINT benefits of the agency's embedded and externally assigned personnel.



Jennifer A.K. Daniel

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UP FRONT

NGA Advances in the Post-Sept. 11 Environment

BY THE OFFICE OF CORPORATE COMMUNICATIONS STAFF

After the events of Sept. 11, 2001, the 9/11

Commission Report emphasized the Intelligence Community's responsibility to communicate and share information between federal agencies to ensure the success of the security and defense missions of the nation.

Eight years after Sept. 11, NGA has made significant strides in this endeavor and has become a leading example in the Intelligence Community for sharing information.

"We are a nation at war. As such we will support our partners with a heightened sense of urgency as a unified GEOINT [geospatial intelligence] community," Vice Adm. Robert B. Murrett, Director of NGA, said. "GEOINT plays a critical role in virtually every Intelligence Community and Department of Defense mission; we will not fail to partner as closely as possible with our counterpart agencies and ensure that GEOINT is effectively utilized whenever and wherever it is needed," said Murrett.

Demonstrating a commitment to acceleration, integration and standardization of GEOINT, NGA is one of the largest users of the new information networks that the 9/11 Commission Report recommended.

During the time preceding Sept. 11, the National Imagery and Mapping Agency (NIMA) developed programs that involved the creation of support teams, integration of work roles and functional management oversight. The 9/11 Commission Report, directed by Congress, identified a "need to restructure the Intelligence Community." Specifically, the commission recommended that procedures for sharing information should provide a better balance between security and disclosure and be accessible through networks that connected multiple agencies. The report presented opportunities for NGA to demonstrate itself as a pioneer in collaboration.

The report propelled the Intelligence Community, as well as the nation, into a new frame of reference: before and after Sept. 11. At NIMA, the report was a catalyst for progress, spurring the integration of mapping and imagery, and emphasizing wider dissemination for national security.

Less than a month prior to Sept. 11, retired Air Force Lt. Gen. James R. Clapper Jr. took the helm of what was still known as NIMA; it was renamed the National Geospatial-Intelligence Agency in 2003 as a symbol of its unifying discipline and doctrine. The agency's mission called for consistent reintegration of cultures and work roles and provided a foundation upon which to face future challenges.

Acceleration of Support Through Deployers

For the past eight years, one of the most significant changes in NGA's posture has been the increase in subject-matter expert support to federal agencies and military partners. By concentrating on the rapid development of a program to train and deploy analysts and support staff, NGA is able to ensure the most accurate GEOINT will be in the hands of the mission partner quickly.

For example, NGA's predecessor organization sent one team to provide GEOINT to the Federal Emergency Management Agency (FEMA) during Hurricane Andrew in 1992. In contrast, in the post-Sept. 11 years, the agency stood up an entire division, offering assistance to federal agencies in support of all hazards, natural and man-made. These included large-scope, high-attendance events such as the Olympics in Beijing 2008, the G-20 Summit in Philadelphia, Penn., in 2009 and the inauguration of the president of the United States in Washington, D.C., in 2009.

The "Tribute in Light" memorial honors those who lost their lives in the Sept. 11 World Trade Center attacks.

DOD Photo



In addition, NGA, along with the U.S. Geological Survey (USGS), developed the Homeland Security Infrastructure Program, which provides a foundation to improve collaboration and joint decision-making regarding homeland security and defense missions throughout federal agencies, including but not limited to the Department of Homeland Security, FBI and U.S. Northern Command.

To aid this enhancement, NGA leadership believed that the analyst could best support the GEOINT partner by providing in-theater geospatial knowledge and products, as well as ensuring round-the-clock assistance back home called “reachback.”

According to NGA historian Dr. Gary Weir, the reachback program began when NIMA analysts were sent to support Special Operations in Afghanistan in 2001. “Analysts were equipped with a standard satellite communications suite and a robust laptop loaded with specific software designed to manipulate images and map data to create nonstandard products,” said Weir. This program for developing response teams has grown exponentially.

In 2009, nearly one-third of NGA’s workforce was deployed to more than 150 sites worldwide, and its number of people deployed has grown 175 percent since 2007 alone. As a result, NGA has provided support to Operation Iraqi Freedom, the Columbia space shuttle recovery in 2003 and the tsunami in the Indian Ocean in 2004, as well as other disasters such as the California wildfires in 2008.

Integration of Tradecraft

Slowly and steadily, NGA moved towards integrating a multitude of work roles and products into one solid tradecraft. NIMA’s product makers were largely segregated into two camps: cartographers making maps and imagery analysts making sense of images. The creation of NGA began a shift toward GEOINT, which is a fusion of skills and products that can be customized for decision makers to access information that can only be understood visually in reference to a geographic location.

Later, NGA’s technology evolved to a platform-neutral stance, meaning information previously located in disparate workstations could now be accessed via a single one, streamlining the physical and virtual world of analysis. In 2009, the Director announced the creation of a single, overarching analytical job known as a geospatial intelligence analyst, which would encompass the wide range of analytical occupations at the agency. This change further solidified NGA’s move towards cultural and logistical solidarity.

Standardization of Products and Policy

With 33 different organizations using GEOINT regularly, consistency regarding its production, dissemination and usage is essential. According to Weir, “Intelligence analysts needed high-quality imagery available uniformly across the Intelligence Community.” Progress came gradually when review authority was granted in 2000, followed by the creation of the National Geospatial Program that assumed control “first over advanced geospatial intelligence in 2003 and then overhead persistent infrared imaging in 2004,” said Weir.

Executive Order 12333, amended in 2008, and the DOD Directive 5105.06, July 2009, formally designate NGA as the functional manager for GEOINT and embody the recommendations made in the 9/11 Commission Report that intelligence be “distributed according to the same quality standards, whether it is collected in Pakistan or in Texas.”

As a result, these partnerships have extended to an ever-increasing number of countries and regions and have resulted in collections in areas that have previously gone unrecorded, such as Africa. NGA, and through it the National System for Geospatial Intelligence, is ensuring and enabling GEOINT collaboration on a national and international level that is unprecedented.

Preparing for the Future

Since one of the main criticisms of the Intelligence Community from the 9/11 report dealt with the lack of sharing among agencies, the Intelligence Community has made significant strides to correct the issue, and NGA has been an active participant using social networking applications. The document recommended that “agencies would still have their own databases, but those databases would be searchable across agency lines.”

The Intelligence Community as a whole has responded to this through use of a social software platform called Intelink to encourage collaboration at all levels. With a combination of information-sharing networks including wikis and blogs, the Intelligence Community is able to share information using a variety of methods and at a speed that was only imagined in decades prior.

Overall, the use of deployers, integrated tradecraft, united oversight and formalized collaborative tools in execution of the mission signifies a cultural shift towards collaboration in the Intelligence Community. NGA stands united with its fellow agencies not only in mission, cooperation and communications but also in its resolution that a tragedy of Sept. 11’s magnitude never happen again. P



UP FRONT

NGA Supports Samoan Island Recovery Efforts

BY SUSAN MEISNER

NGA supported the Federal Emergency Management Agency (FEMA) with analysis, unclassified commercial satellite imagery and geospatial intelligence products of the Samoan Island areas devastated by the September 2009 earthquake and resulting tsunami. FEMA, a component agency of the Department of Homeland Security, was appointed as the lead federal agency for the crisis. NGA supported FEMA in that role.

NGA also provided the general public with access to some of the images on NGA's crisis response portal, NGA-Earth.org, a satellite imagery and map viewer. NGA-Earth.org is updated as new images are made available. In addition to the information hosted at this location, the Web site provides links to other federal agency sites and is an access point from which to leverage other NGA geospatial expertise and products.

Originally established in response to Hurricane Katrina in 2005, the NGA-Earth site uses the Internet to provide the public a single, easy-to-use entry point for locating timely, relevant, unclassified geospatial information in

the event of a natural disaster or crisis. The site is also a means to communicate critical information to first responders, as well as to allow the public the ability to broadly assess property damage without having to physically return.

Other geospatial intelligence products that NGA provided to FEMA, the U.S. Pacific Command, the U.S. Coast Guard and other government agencies included graphics of major infrastructure such as the locations of airports, hospitals, police and fire stations, emergency operations centers, hazardous material locations, highways and schools. The products also included damage assessments.

These types of products greatly assist first responders and those coordinating and planning relief efforts. The graphics provide a common operating picture that has helped enable local, state and federal government elements to work effectively together since Hurricane Andrew in 1992. P

Susan Meisner is a public affairs officer in the Office of Corporate Communications.

Residents clean up debris in Pago Pago, American Samoa, Oct. 1, 2009.

DOD Photo





Iraq Relief Operations Build Cooperation

BY MATTHEW W.

For years, the U.S. Army Corps of Engineers and civil affairs officers have complemented the traditional combat operations of the U.S. military. However, the unique conflicts of the recent decade have demanded significant flexibility from all U.S. forces. Serving for 27 months as a U.S. Army intelligence officer with the 1st Cavalry Division in Iraq, this author observed the humanitarian relief mission evolving into an essential pillar of U.S. and coalition strategy and witnessed firsthand the invaluable contributions of NGA deployed personnel to that mission.

War, disease, natural disasters and sectarian violence place unimaginable burdens on civilian populations. Humanitarian assistance by the military can lessen these burdens, build partners and minimize violent extremism. Assistance to Iraqi civilians has helped create and continues to create strong allies. Geospatial intelligence (GEOINT) has been crucial to this effort. GEOINT contributions have improved the lives of Iraqis and saved the lives of warfighters.

An Extensive Need

The United Nations estimates that over 25 million people around the world are in the midst of some form of humanitarian crisis; many have been displaced from their homes due to war or violence. Over the last 30 years, Iraq has been particularly affected, with over 2.5 million people displaced from their homes or tribal areas during the past six years.

The forced mobility of some Iraqis has left them vulnerable to disease, gang activity and terrorist recruitment. Sectarian divisions have complicated this situation, forcing Iraqis to choose allegiances that have further marginalized some populations. In many Iraqi neighborhoods, fluid sectarian populations could shift from week to week. Such massive dislocation devastates the displaced, hampers relief efforts and makes it difficult to collect and analyze the data needed to identify areas on which to focus humanitarian efforts. Gaining control of such an environment requires information and innovative solutions.

A GEOINT Solution

The foregoing observations demonstrate that humanitarian crises are intelligence problems. Providing

solutions to these crises helps alleviate the corollary problems associated with them. Realizing this, the NGA officers and analysts deployed with the 1st Cavalry Division wrestled with how to provide humanitarian aid in the midst of combat operations. These deployers contributed invaluable GEOINT in a number of ways.

NGA analysts provided innovative ideas and nontraditional solutions to these intelligence problems that delivered results. NGA personnel built graphics using social and cultural markers that outlined the sectarian breakdown of Baghdad neighborhoods; identified areas occupied by displaced and underserved members of the population; provided commercial imagery products to assist the Iraqi government; supplied ad hoc, analytic field training to the 1st Cavalry's collection management section; and expedited requests for products to support troops in the field.

In one example, an analyst suggested that patrolling soldiers take note of the geographic coordinates of severe concentrations of struggling or displaced people. NGA analysts exploiting this raw data created software for military and civilian relief organizations to track needs, build more sophisticated crisis models and supply better and more immediate assistance. Collecting coordinates became standard operating procedure, resulting in countless Iraqis receiving humanitarian support.

Using geographic coordinates, agency personnel also collaborated with 1st Cavalry intelligence analysts to identify areas with high concentrations of temporary housing structures. Temporary structures suggest that the inhabitants are displaced and probably in



need of humanitarian aid. In a case that confirms the value of this endeavor, NGA representatives passed the coordinates of a temporary settlement to U.S. units in the area, who in turn coordinated with military chaplains to provide the affected Iraqi citizens with food, water and medical care. This effort significantly improved the quality of life in the area, which resulted in a dramatic decrease in attacks on U.S. forces and a marked increase in cooperation from local Iraqis.

Recent military operations, including Operation Iraqi Freedom, have involved both conventional and unconventional approaches, including humanitarian relief. Likewise, intelligence officers do not support combat operations alone. An essential part of the job entails helping Iraqis meet basic human needs. NGA and GEO-INT make a difference in Iraq, not just for the warfighter, but also for the local population. As U.S.

and allied strategy continues to evolve, NGA's support to all operations in Iraq, including humanitarian relief, remains key and indispensable. NGA's collaboration with military and civilian organizations will continue to reduce harsh conditions and promote cooperation between the Iraqis and coalition forces. P

Matthew W. is a staff officer in NGA's Office of Geospatial Intelligence Management. He served with the U.S. Army for seven years.



A U.S. soldier hands out water purifiers near Tarmiyah, Iraq.

DOD Photo



New NGA–USDA Techniques Assess Harvest Yields

BY ROBERT TETRAULT

Just weeks into the 2007–08 growing season, the Iraqi Ministry of Agriculture knew that wheat and small grain farms were in trouble in the country's normally plentiful northern region. A partnership between NGA and the U.S. Department of Agriculture (USDA) had detected an impending drought early enough for Iraqi government officials to avert a famine by arranging for food shipments to the affected areas.

Early warning of the drought resulted from a successful pilot project conducted by NGA and the USDA's Foreign Agricultural Service (FAS), the primary source of foreign crop production data. The project developed new remote sensing techniques for assessing crop health and predicting harvest yields in growing regions where USDA lacked adequate ground condition information.

One reason that the United States closely monitors international crop health is that a stable food supply is critical to the overall security of a nation. USDA evaluates and publishes FAS information in its forecast of supply and demand for U.S. and global crops. USDA FAS makes its production forecasts based on a convergence of evidence that involves volumes of structured and unstructured information, including low- and medium-resolution multispectral satellite imagery as well as meteorological data. This remotely sensed information is usually supplemented by reports from trained observers located throughout the growing regions being monitored. However, in Iraq and some other countries, ground observers do not exist.

The NGA–USDA project set out to determine if the high-resolution commercial satellite imagery often used by NGA could be integrated into existing FAS methods. Could analysis combining low-, mid- and high-resolution multispectral satellite data help fill information gaps?

Using Multiple Satellite Sensors for Multispectral Analysis

For intelligence applications, NGA complements national remote sensing resources with high-resolution

satellite imagery from commercial vendors. During the pilot project, as in its other crop assessment activities, USDA FAS relied on low-resolution data from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) sensor and other systems and on medium-resolution imagery from the Indian Advanced Wide Field Sensor (AWiFS).

The coarse-resolution MODIS sensor played two key roles, revealing precipitation trends and vegetative abundance over large areas. Comparison of MODIS indices from the 2007–08 Iraqi growing season against a NASA archive showed much lower abundance. USDA analysts then turned to AWiFS imagery from the Indian Resourcesat-1 satellite with its 56-meter spatial resolution and 740-kilometer-wide swath to look more closely at known wheat- and grain-producing areas. AWiFS' resolution can identify farming areas, and its multispectral bands and frequent five-day revisit make the sensor ideal for monitoring nationwide agricultural conditions. Vegetative health indices derived from these images confirmed that the biomass growth was well below that of previous years.

At this point, analysts normally would have turned to ground observers to quantify the drought impact by field and crop type. But in the pilot project, NGA instead obtained high-resolution commercial satellite imagery of 18 farm locations in northern Iraq acquired by DigitalGlobe's QuickBird satellite. The 2.5-meter resolution QuickBird images were captured at five different times during the growing season.

This high-resolution multispectral imagery provided details into what was happening in each field. The imagery differentiated wheat from other crops and revealed whether farmers were actively working the fields and irrigating them. USDA combined QuickBird and AWiFS images acquired at about the same time to create a sequence showing the crop growth—or lack of it—over time.

Analysts wanted to use the spectral values of wheat fields in QuickBird imagery to identify wheat fields elsewhere in the AWiFS imagery to make a nationwide assessment. However, they found it difficult to extrapolate spectral values across an image covering such a wide area as the AWiFS covers because variations in atmospheric conditions across the scene had created distortions in the values. This problem was solved by a USDA subcontractor, which developed a technique to normalize atmospheric interference and correlate QuickBird spectral values across an entire AWiFS scene.

Unfortunately, the news for northern Iraq was not good. The number of fields containing healthy wheat and other grains was well below normal, confirming the impending mid-season drought. USDA FAS and NGA promptly disseminated this information to U.S. and Iraqi officials to arrange for wheat purchases from other countries.

Refining the Process

NGA and USDA participants considered the initial pilot a success. With the drought persisting, NGA gave the green light to continue the effort into the 2008–09 growing season, with expanded activities focusing on southern Iraq. This next phase applied the same combination of low-, mid- and high-resolution multispectral satellite imagery with several refinements.

One was an innovative new way to create cloud-free mosaics without losing information content. A satellite mosaic of a large region is typically made by digitally

stitching together multiple images to provide a single view of the entire area. The USDA subcontractor developed a technique to clip out cloud-covered pixels from one scene and replace them with cloudless pixels from another, generating a cloud-free mosaic.

In addition, USDA FAS analysts have developed a product using MODIS imagery that has proven most helpful in identifying seasonal crop rotations in areas where there are no available ground truth capabilities. This seasonality product is being used in conjunction with other weather data to help develop an additional product to further assess the extent of drought in a given area.

Conclusion

The NGA–USDA partnership helped detect and prevent a looming humanitarian crisis in Iraq. Many nations face similar food security issues. Although these techniques may never entirely replace human observers, NGA and USDA expect to see the multiresolution analysis developed during the Iraq pilot expand to improve agricultural assessments in other parts of the world where USDA lacks sufficient ground condition information. By combining expertise and data, the NGA–USDA partnership provides an excellent example of interagency cooperation serving the United States and the global community. ▢

Robert Tetrault is the satellite imagery archive manager for the U.S. Department of Agriculture, Foreign Agricultural Service, Office of Global Analysis, International Production Assessment Division.

Photo by Getty Images

Irrigation and Agriculture Assessments

By Ida E.

In addition to the NGA–USDA drought detection project, and at the request of lead NGA analysts in Iraq, civil affairs battalions and provincial reconstruction teams, the agency has been providing irrigation and agriculture assessments throughout Iraq's agriculturally dominant provinces to support ongoing stabilization and reconstruction efforts. NGA uses a smart sampling technique that combines DigitalGlobe's high-resolution QuickBird and WorldView-1 commercial satellite imagery, foundation data, historical vegetation information and results from USDA's analysis of relative agriculture abundance

derived from low-resolution multispectral satellite imagery. Sample areas are analyzed to assess irrigation attributes and vegetation abundance. Furthermore, USDA's Foreign Agricultural Service is providing hands-on training for NGA analysts to identify seasonal crop rotations to support customer requests. Since March 2008, NGA has provided information on irrigation or agriculture for over 20,000 square kilometers throughout Iraq. NGA continues to work closely with USDA, imagery scientists and NGA's commercial imagery partners to provide continued support to customers in theater. ▢

Ida E. is a geospatial intelligence analyst in the Office of Targeting and Transnational Issues.



Geospatial Analysis Reveals Water Levels in Arid Regions

BY TRESSA E.

Water is a strategic natural resource, particularly in arid regions such as the Middle East and Central Asia. Used for agriculture, electric power and consumption, water affects a country's stability. Failure to manage it responsibly can invite disaster. Because water is such a concern, NGA actively monitors water levels throughout the Middle East and Central Asia using readily available imagery from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) sensors.

MODIS sensors, carried on board NASA's Terra and Aqua satellites, have collected global imagery daily since 2003, often twice a day. These images provide NGA the ability to constantly monitor environmental issues throughout much of the world and are accessible within hours of collection from NASA's MODIS Rapid Response System Web site (rapidfire.sci.gsfc.nasa.gov). Resolution varies from 250 meters to two kilometers, and the imagery is available in true color or false-color composite. The bands or visual wavelengths assigned in the false-color composite are ideal for revealing features such as snow, vegetation and water.

Restoring Iraq's Southeastern Marshlands

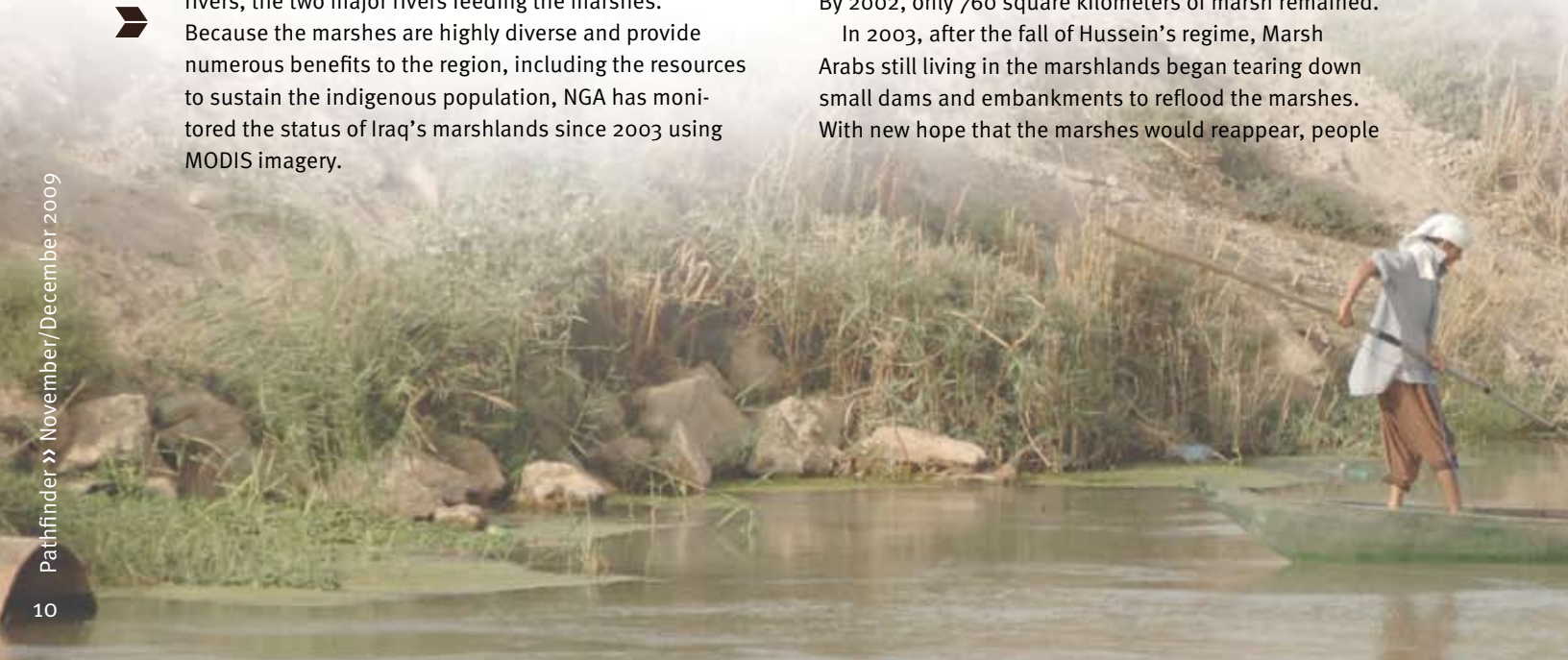
Iraq's marshlands once covered 15,000 square kilometers at the convergence of the Tigris and Euphrates rivers, the two major rivers feeding the marshes. Because the marshes are highly diverse and provide numerous benefits to the region, including the resources to sustain the indigenous population, NGA has monitored the status of Iraq's marshlands since 2003 using MODIS imagery.

The marshes, historically one of the most biologically diverse areas in the world, supported many species of birds, fish, mammals and vegetation. However, beginning in the 1960s, upstream dam construction in Turkey, Syria, Iraq and Iran limited the amount of water flowing into the marshes introducing rapid changes. The annual spring floods from snowmelt, which had replenished the marshlands, essentially disappeared. Many experts feared the decreased flows would irreparably harm and eventually destroy the marshes.

The indigenous population, known as Marsh Arabs, has lived in the marshes for over 5,000 years and depends on them for food, water filtration, flood control, housing materials and a defensive barrier. With the water flow reduced from upstream dams, many Marsh Arabs left their villages because the marshes could no longer support their way of life. Those who chose to remain suffered malnutrition and drank untreated water, causing numerous cases of water-borne diseases. No primary healthcare facilities or schools support the population.

Following the first Gulf War in 1991, Saddam Hussein's regime drained most of the marshes and destroyed many villages to increase control over and punish rebellious Shiites who hid in the marshlands' variable terrain. Hussein's security forces displaced many Marsh Arabs. By 2002, only 760 square kilometers of marsh remained.

In 2003, after the fall of Hussein's regime, Marsh Arabs still living in the marshlands began tearing down small dams and embankments to reflood the marshes. With new hope that the marshes would reappear, people



started returning. Iraq's Ministry of Water Resources hopes to restore 75 percent of the original marshland.

To delineate the marshland's original extent, the United Nations Environment Programme (UNEP) used Landsat imagery from 1973 to 1976. The UNEP estimation serves as the basis for NGA's analysis.

Each spring, NGA imagery analysts determine the extent of the marshes by using a 2003 land cover classification template they derived using commercial imaging software. Using this template, the software automatically extracts image pixels representing water and vegetation to allow all images to be compared equally. Comparing the extent of vegetation and water yearly reveals the scope of recovery. Initially the marshlands expanded rapidly. However, analysis has shown a decline in marsh area since 2007, most likely due to severe drought conditions and upstream diversions. Knowing the status of marsh recovery, Iraqi authorities can take appropriate measures to achieve their goal.

Monitoring Reservoirs on the Tigris and Euphrates Rivers

NASA's large historical image library can also aid U.S. reconstruction and stabilization efforts in Iraq by helping to determine the relative storage of water resources across a basin or identifying drought or downstream flooding early. Using MODIS imagery, NGA analysts regularly monitor seasonal fluctuations, annual variations and significant differences inside reservoirs behind key dams in the Tigris-Euphrates basin.

Analyzing MODIS imagery on a daily basis helps analysts assess seasonal changes in the extent of surface water in specific areas of a reservoir. Assuming reservoir water levels rise with increasing water extent, water level changes are determined by measuring variations in the extent. Water absorbs more light in certain wavelengths,

or bands, imaged by MODIS, producing a strong inverse correlation between MODIS images and water levels. As water level and extent increase in an area, the radiance of the water decreases.

Predicting Afghanistan Snowmelt

Afghanistan is very mountainous. The high elevations receive an abundance of snow in the winter. When the snow melts in spring, downstream flooding poses a concern for the local population. To predict the possibility of flooding, NGA analyzes MODIS imagery weekly to track the snow extent. Analysts employ image processing software to distinguish snow from other environmental features by manually extracting the image pixels that represent snow. By comparing one week's change in snow extent, analysts gain an understanding of the rate and location of the past week's snowmelt and assess where localized flooding may be an immediate concern. They also compare snow extent from previous years during the same time frame to predict if the snowmelt season is average or if there may be a potential for flooding downstream at lower elevations.

Conclusion

Water remains critical to stability in the Middle East and Central Asia. Using MODIS imagery, NGA monitors and detects large-scale environmental changes throughout the region. Because the imagery covers most of the world, is updated daily and includes a historical data set back to 2003, MODIS provides a historical baseline of the area of interest so that variations from normal conditions can be easily identified. By monitoring these variations, NGA predicts potential disasters to help restore and protect communities and nations. P

Tressa E. is a geospatial intelligence analyst in the Office of Targeting and Transnational Issues.

Two Iraqi men fish the marshlands in the Maysan Province of Iraq. Iraqis fish the marshlands to feed their families and to sell at their local market.

DOD Photo

Photo Illustration by Anika McMillon



Student Intern Supports Afghanistan's Provincial Reconstruction

BY TARASSA S.

As world events develop, NGA constantly faces the challenge of designing new methods to address evolving situations. This turbulent atmosphere makes NGA an exciting place to work for everyone from the agency's leaders to student interns who are getting their first taste of serving the nation. Through an unusual partnership, NGA developed situational awareness products to support U.S. reconstruction efforts in Afghanistan and further U.S. national strategy.

Provincial Reconstruction Teams

Currently there are multiple provincial reconstruction teams (PRTs) in Afghanistan, consisting of civilian and military personnel from 15 nations, all members of the NATO-led International Security Assistance Force. Some PRTs are multinational, while others are made up of a single nation's personnel; half are led by the United States. Established in 2002 as part of an international effort to help extend the authority of the Government of the Islamic Republic of Afghanistan, PRTs support reconstruction and economic development activities.

Civilian PRT members work with Afghan officials, international organizations such as the United Nations Assistance Mission in Afghanistan, and nongovernment organizations (NGOs) to promote political, economic, humanitarian and social welfare development. Military elements provide security, medical assistance, transport and engineering. Several U.S. civilian agencies, including the U.S. Agency for International Development, Department of Agriculture and Department of Commerce,

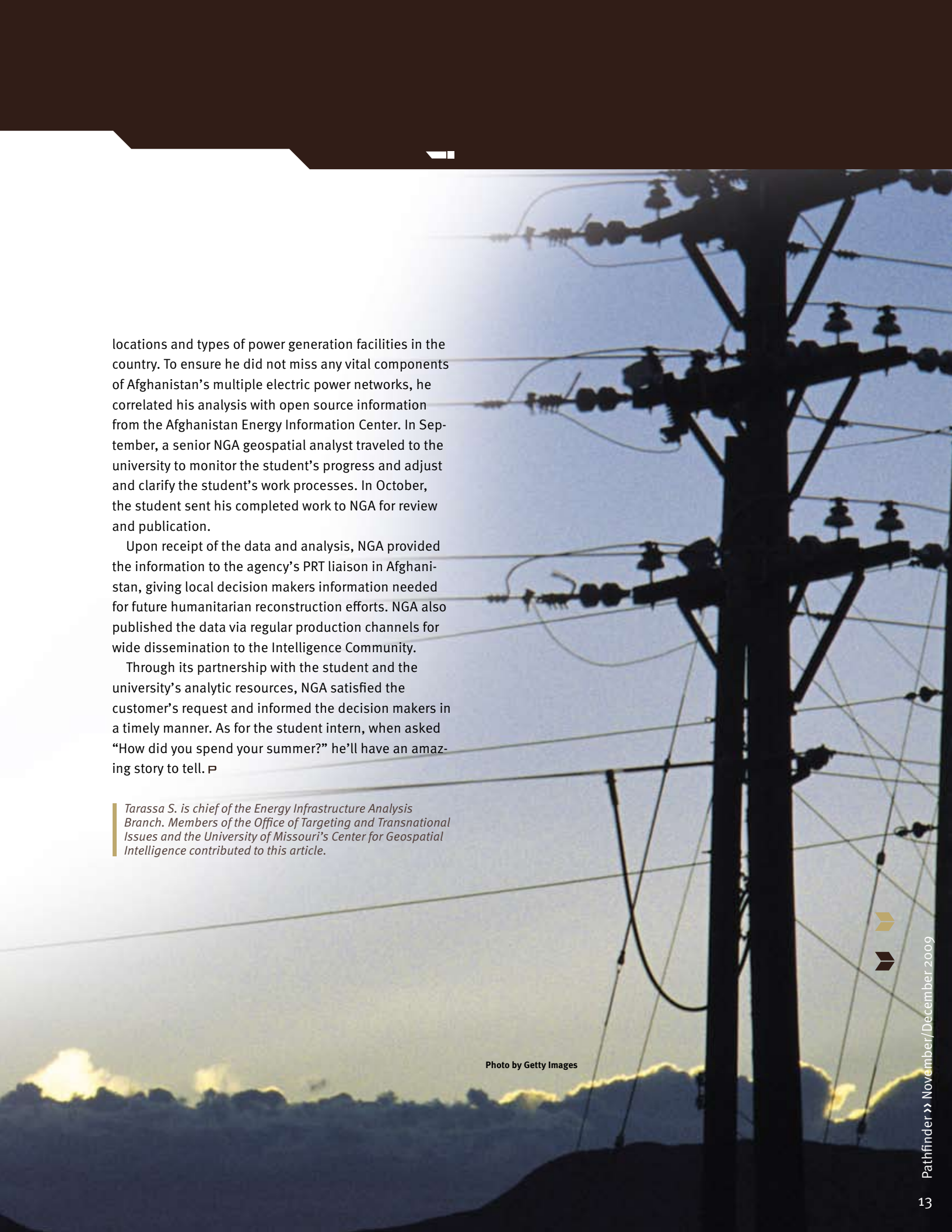
have representatives in the PRTs. Given the composition of the PRTs, information sharing and civil-military collaboration are critical to efficient operations.

Portraying the Electric Power Infrastructure

A primary goal of the PRT efforts in Afghanistan is to improve the creation and distribution of electric power to the civilian population, which in turn would improve the quality of daily life. In August 2009, NGA was asked to provide data and information about the current status of Afghanistan's high-voltage national-level electric power infrastructure, including the location of current transmission lines and power generation facilities. Depicting the current state of civil infrastructure and economic development assists PRT decision makers in planning improvements to promote stability in Afghanistan.

Over the summer of 2009, an undergraduate student intern studying civil engineering at the University of Missouri worked at NGA learning electric power infrastructure and identification of that infrastructure on imagery. In August, NGA arranged with the university's Center for Geospatial Intelligence to allow the student to create the requested Afghanistan electric power infrastructure data in a telework agreement while attending fall semester classes. The center, an interdisciplinary academic research facility, focuses on processing and exploiting geospatial data and information for national security applications.

Under this unique arrangement, and with oversight from a senior NGA geospatial analyst, the student analyzed commercial imagery, which NGA provided, for electric power infrastructure. He extracted feature data of the location of the major power lines and identified the



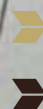
locations and types of power generation facilities in the country. To ensure he did not miss any vital components of Afghanistan's multiple electric power networks, he correlated his analysis with open source information from the Afghanistan Energy Information Center. In September, a senior NGA geospatial analyst traveled to the university to monitor the student's progress and adjust and clarify the student's work processes. In October, the student sent his completed work to NGA for review and publication.

Upon receipt of the data and analysis, NGA provided the information to the agency's PRT liaison in Afghanistan, giving local decision makers information needed for future humanitarian reconstruction efforts. NGA also published the data via regular production channels for wide dissemination to the Intelligence Community.

Through its partnership with the student and the university's analytic resources, NGA satisfied the customer's request and informed the decision makers in a timely manner. As for the student intern, when asked "How did you spend your summer?" he'll have an amazing story to tell. ▢

Tarassa S. is chief of the Energy Infrastructure Analysis Branch. Members of the Office of Targeting and Transnational Issues and the University of Missouri's Center for Geospatial Intelligence contributed to this article.

Photo by Getty Images





GEOINT Focuses World Attention on the Troubled Darfur

BY DR. GARY E. WEIR

Very often the most casual effort to communicate can produce extraordinary results. Upon receiving a new regional account in 2003, one of NGA's imagery analysts decided to call his colleagues in other Intelligence Community agencies to inform them of his account change and offer his assistance if needed. He had been assigned a region of Africa that showed distinct signs of instability, and he knew that a time for mutual assistance might soon come.

Early in 2003 the Sudanese Liberation Army and the Justice and Equality Movement began attacking government targets in Sudan, accusing the government in Khartoum of oppressing black Africans in favor of Arabs. After receiving an urgent request for help from a colleague he had contacted earlier, the analyst began developing a baseline of imagery and maps to document events in the Darfur region, which formed part of his new account. At about the same time, other NGA analysts studying images in the area of Darfur began noticing changes in population distribution. By April and May 2004, they all began to see evidence of several hundred villages completely destroyed by fire.

The application of geospatial intelligence (GEOINT) tradecraft and effective inter-agency collaboration revealed a humanitarian crisis to that point hidden from the outside world. An exhibit at the NGA Museum in St. Louis, Mo., opened in September, examining the ways analysts used available technologies to create the GEOINT products that played a role in bringing the conditions in Darfur to the attention of the world.

In April 2004, the State Department Humanitarian Information Unit formally tasked NGA to look for relevant imagery. The requirement was to combine data about damaged and destroyed villages with commercial imagery and displaced population information to create a series of maps and graphics titled

“Sudan (Darfur) – Chad Border Region: Confirmed Damaged and Destroyed Villages.”

In addition to refugee camps and demolished villages, the maps also indicated the spatial relationship of internally displaced persons camps, United Nations High Commissioner for Refugees (UNHCR) camps, groundwater, roads, airfields and healthy vegetation, as well as general accessibility during the rainy season. Camp locations were provided by UNHCR, baseline data came from NGA and the Army Corps of Engineers contributed hydrologic data. Additional data sources included the UN World Food Program and NASA. NGA used many imagery and cartographic resources to provide information to national and international leaders. Some of those sources included panchromatic and multispectral images.

As the crisis in Darfur escalated, Sen. John McCain received a briefing from NGA analysts. In June 2004, he took that knowledge, along with unclassified NGA briefing boards, to the Senate floor where, with



the help of GEOINT, he was able to bring global attention to the crisis. What began as an effort to contact fellow professionals ended by illuminating a humanitarian tragedy that needed international attention.

The recent history of Sudan's Darfur region demonstrates the importance of collaboration across the Intelligence Community, the power of geospatial tradecrafts to derive essential knowledge and the unique contribution GEOINT can make to international security and world peace. Although GEOINT cannot provide tangible relief to displaced Darfuris, it has educated decision makers and reminded governments that the world is watching their actions. It has also enabled aid workers to locate existing refugee camps, select sites for

new camps, facilitate food distribution and quantify the effects on the population of the Darfur region of a crisis almost too great to comprehend. ▢

Dr. Gary E. Weir is the NGA Historian.



Internally displaced persons in Darfur, Sudan.

USAID photo



NGA Teams Key to Post-Hurricane Recovery Efforts

BY RICHARD A.

Since Hurricane Andrew devastated parts of South Florida in 1992, geospatial intelligence (GEOINT) has been considered vital to the nation's disaster response and recovery efforts. NGA closely monitors all hurricanes to be ready to offer assistance when requested by the Federal Emergency Management Agency (FEMA). If a hurricane is expected to affect the United States, NGA can be on site at a moment's notice.

The agency's response teams draw from the broader NGA Domestic Deployer Team, which includes highly skilled volunteer analysts and staff officers from across the agency. The volunteers receive specialized training to become part of these crucial analytical teams that have proven to be key players in disaster relief, as demonstrated by the response to Hurricane Ike, the third-most destructive hurricane ever to make landfall in the United States.

When Hurricane Ike struck Galveston, Texas, on Sept. 13, 2008, at FEMA's request an NGA team had already deployed to Houston with the agency's Domestic Mobile Integrated Geospatial-Intelligence System, a self-contained command vehicle that provides analysts with the ability to produce geospatial products at the scene of a disaster or other special security event, such as a presidential inauguration. The analysts had been tracking the 2008 storm season and had already spent time in Atlanta, Ga., tracking Hurricanes Gustav and Hanna before heading to Texas. Upon arriving in Houston, the team quickly began to disseminate GEOINT products from their mobile operations center.

The NGA team provided assistance to the FEMA's Urban Search and Rescue (US&R) operations, which encompass federalized firefighters and relief workers from across the United States who specialize in search and rescue, disaster response, and emergency triage and medicine. Before search teams had even put boots on the ground, the deployed analysts had supplied overviews of damaged areas to identify ingress and egress routes and assess the size and scope of the search needed to complete the mission.

The NGA deployers created products using high-resolution commercial imagery from GeoEye or DigitalGlobe and graphical data overlays to convey different aspects of the hurricane damage. The analysts performed dam-

age assessments that identified critical infrastructure and measured flooded areas. They determined population density by integrating LandScan™ data, used for estimating populations, into their analysis. US&R task forces received search maps that included all this information and referenced the U.S. National Grid (USNG), a simplified X, Y coordinate system for finding domestic locations. The NGA search maps enabled the task forces to more accurately locate civilians affected by the hurricane and more efficiently manage recovery resources.

The deployed team also incorporated additional data contributed by NGA reachback cells to supply daily updates to damage and flooding assessments and evaluations of ongoing relief efforts. NGA operated 24/7, with the deployed analysts working in excess of 16 hours a day to support the FEMA US&R operations as a critical mission partner. Furthermore, the deployers directly accompanied the US&R teams into damaged areas of Galveston to deliver onsite guidance and near-real-time situational awareness.

The quality of support to FEMA attests to the hard work of NGA's GEOINT analysts. One product, which identified the level of damage in parts of Galveston by comparing the damage before and after the storms, was shown to former President Bush to help illustrate the extent of the damage and the impact of the hurricane as he toured the devastated areas.

NGA's preparation for and response to Hurricane Ike prevented greater disaster and exemplified the value contributed to domestic partners by the agency's deployed teams. Through the FEMA-NGA partnership, future crises will be met with equal dedication and readiness. P

Richard A. is a geospatial intelligence analyst in the Office of the Americas.





DOD Photos

Photo Illustration by Anika McMillon





Deforestation Analysis Complements Cambodia Conflict Assessment

BY CHRIS L.

In May 2009, NGA had the opportunity to study land cover change in collaboration with an Interagency Conflict Assessment of Cambodia. The assessment helped develop a holistic interagency understanding of the current dynamics in Cambodia that may lead to conflict and also serves as a foundation for more effective U.S. engagement with Cambodia.

Land cover science describes the overall human modification of the Earth's land surface. Observable land cover changes occur every day—whether as construction of a new housing subdivision or someone installing a backyard swimming pool. Scientists and members of the Intelligence Community study changes in land cover across the globe, such as conversion of forests to agricultural land, because the effects can drive instability in ecosystems, populations and governments. Additionally, human-driven changes in land cover have had a direct effect on global climate change. For example, since 1850, approximately 35 percent of carbon dioxide emissions resulting from human activity have come from land use.

In 1998, Cambodia emerged from more than 30 years of civil war, foreign occupation and genocide. This instability brought massive exploitation of the country's natural resources—especially its forests—giving Cambodia the third-highest rate of deforestation in the world, according to the United Nations Foreign Agriculture Organization. The continued high rate of deforestation in Cambodia could undermine the stability of this important ecosystem that the country's largely rural population relies on, leading in turn to population migrations and grievances that could strain the country's relatively fragile democratic system.

To contribute to the Interagency Conflict Assessment, NGA sought to identify the amount of deforestation in a large section of western and central Cambodia between 2005 and 2008. Previously existing land cover types were identified using a one-kilometer resolution land cover classification produced by the Global Land Cover Facility, a center sponsored by the University of Maryland and NASA that uses satellite data for land cover research. The center's work ensured that analysts

focused only on land cover types classified as forests and woodlands. Analysts calculated the difference in intensity of identified forest vegetation between 2005 and 2008 using normalized difference vegetation index (NDVI) measurements derived from low-resolution, composite images. Vegetation indices, including NDVI, are helpful for monitoring the health and vigor of vegetation and are used in products displaying land cover and land cover changes.

The NGA study revealed areas where there had been both increases and decreases in forest cover intensity. The changes in intensity were determined to indicate changes in land cover, including changes resulting from deforestation and reforestation. An area of 1,812 square kilometers showed decreases in forest cover, while 1,268 square kilometers showed increases. A surprising feature of the changes in Cambodia's forest cover was that 45 percent of the decreases had occurred within areas identified as protected by the United Nations Environment Programme. This corroborated evidence that Cambodia's government was having difficulty enforcing regulations meant to reduce the rate of deforestation.

In its study of forest cover changes in Cambodia, NGA took advantage of the free-of-charge, easily downloadable and scientifically sound datasets that government agencies and academia make readily available. This resulted in a relatively simple, quickly constructed product that provided situational awareness and context for the Interagency Conflict Assessment. The alternative, involving a potentially several-months-long process, might have rendered an answer too late to be relevant.

NGA's contribution to the Cambodia report marks the first time the Intelligence Community has been solicited to provide input to such an assessment of potential conflict. By filling the data gap, NGA's analysis provided the foundation for more informed, effective and holistic U.S. relations with Cambodia. The agency will continue to work with other agencies that monitor environmental processes and will take advantage of their expertise and data in the agency's analysis. P

Chris L. is a geospatial intelligence analyst in the Office of Targeting and Transnational Issues.



Photo by Getty Images



Agency Aids Humanitarian Mission to Georgia

By JIM R.

On Aug. 7, 2008, fighting broke out between Russian and Georgian forces over the separatist region of South Ossetia. Several days of fighting created a humanitarian crisis that NGA helped alleviate.

Early in the crisis, the U.S. European Command (EUCOM) asked NGA to assess the command's current maritime data holdings for the region. After a careful review, maritime analysts found that many products were out of date, but that newer sources of information were available to help provide a current maritime operating picture.

The agency's Maritime Crisis Team, supported by multiple maritime analysts, responded to numerous requests for products, information and tasks from the NGA Support Team at EUCOM, U.S. Naval Forces Europe (NAVEUR) and the NGA Georgia Crisis Action Team. NGA quickly provided Image Charts, Standard Nautical Charts and specialized graphics showing U.S. ship traffic in the Black Sea.

NGA's Maritime Services determined that current chart coverage was inadequate to support safe navigation in and out of several Georgian ports. Maritime's advanced geospatial intelligence unit quickly produced two Image

Charts suitable for the U.S. Navy and U.S. Coast Guard to use for mission planning until the new Standard Nautical Charts could be produced.

Mariners could download and print these Image Charts in theater from NGA's Maritime Crisis intranet page.

Within the few years prior to the crisis, the Naval Oceanographic Office

(NAVO) had completed several surveys in the area of Georgia and the Black Sea area. NGA quickly incorporated these surveys into its new products. Compiling hydrographic surveys can be very complicated and time-consuming. However, NGA applied the NAVO surveys to the charts with unprecedented speed to provide U.S. vessels delivering assistance with products safe for navigation. Analysts applied the compilation updates and created new editions of the charts via the agency's Enterprise Product on Demand Service (EPODS), which produces layered Portable Document Format (PDF) files that can be printed directly on a printing press or a large-format plotter. These PDF files are small enough to be easily transferred electronically. Most can be e-mailed directly to the agency's NAVEUR partners, who can print the files in theater for use by the Navy and Coast Guard.

Maritime Services also provided support by analyzing the ship routes to the Black Sea using a relatively new method of analysis wherein marine analysts compare the Digital Nautical Chart (DNC®) data to hardcopy charts from a mariner's perspective, looking for problems that Navy ships may encounter en route to their destination. This quality assurance step ensures that the DNC® is usable by mariners by validating how well the Navy's digital chart system displays the DNC® data.

NGA's Maritime Services worked days, evenings and weekends to support the effort, producing five new or updated hydrographic products to serve the humanitarian mission in Georgia. Cmdr. Robert W. Witzleb, NAVEUR's staff oceanographer, said, "The NGA rapid turnaround of charting was very much appreciated and helpful ... Your team quickly answered the call." This rapid turnaround of products was possible only through the development of new cartographic technology such as EPODS and the steadfast dedication of NGA's nautical cartographers and marine analysts. ▢

Jim R. is a branch chief within Maritime Services.

U.S. Army Brig. Gen. John Miller hands out candy at an internally displaced persons facility in Tbilisi, Georgia.

DOD photo

OUR HERITAGE

Lunar Cartography Informed Early Space Program

BY DR. GARY E. WEIR

Before anyone can show the way, he or she must know the road ahead. During the Renaissance and the Age of Exploration in the 14th and 15th centuries, only cartographers and the navigators they supported dared venture beyond the horizon. They had knowledge available to only the fortunate few. This knowledge, rendered in maps, enabled discovery and communicated in a useful and often beautiful way the secrets of a mysterious and unknown world. While we often find photographic images more arresting, maps possess symmetry, beauty, familiarity, and great practical utility. These qualities have served humankind for millennia.

With cartographers and their tools, the world seems manageable, discovery and safe return seem possible. Indeed each journey of discovery usually had the making of maps as part of its purpose: discovering landmarks, locating great natural phenomena, measuring distance and relating everything observed one to the other. Maps impose a necessary and comforting order on the unknown.

The cartographer Martin Waldseemüller named North and South America for a fellow cartographer and explorer, Amerigo Vespucci. Prince Henry the Navigator, Vasco DaGama, Christopher Columbus and John Cabot depended upon maps and charts for sailing the Atlantic Ocean or navigating the length of Africa's coastline. Sir Francis Drake depended upon maps to accomplish his raids on the Spanish Empire in the new world as well as his circumnavigation of the globe in 1580. They never ventured forth without the best maps and charts drawn by the best cartographers. Explorers with their eyes on a journey to the moon proved no different.

Even before Alan Shepard became the first of the Mercury Seven astronauts in space during his 1961 suborbital flight, both the U.S. Air Force and the U.S. Army concluded that national discussions about space and exploration required venturing well beyond the still barely defined goals set for the Mercury Program. Beginning in 1957 and 1958, respectively, the Air Force Aeronautical Chart and Information Center (ACIC) and the Army Map Service (AMS) initiated efforts to collect telescope observations and photographic data with an eye toward composing maps of the moon. With this step, the cause of lunar mapping enlisted for the first time the services of professional cartographers experienced in the production of terrestrial maps of the highest quality. The outcome of their effort quickly surpassed all extant lunar cartography.

Photo by Getty Images





ACIC and AMS, absorbed in July 1972 by the Defense Mapping Agency, an NGA predecessor, provided the agency with deep roots in discovery and the manned space program. Without ACIC, AMS, DMA, and NGA, NASA would not have at hand and portable the particular knowledge of the moon so necessary to the American manned space missions.

In 1957, the Air Force Cambridge Research Laboratory worked under contract with the University of Chicago's Yerkes Observatory in Wisconsin to collect the best available photographs of the moon. The planned publication of these images would offer a baseline of the best 281 lunar photos from over 1,200 prints collected. Many sources contributed images to the effort including Yerkes: the observatory at Mt. Wilson in Pasadena, Calif.; the Lick (San Jose, Calif.) and McDonald (Fort Davis, Texas) observatories; and France's Pic du Midi Observatory. The resulting Air Force Lunar Reference Mosaic appeared in 1960 under the aegis of the University of Chicago Press. ACIC assembled the final draft and took charge of government distribution.

As frequently as we rely on images of the moon from television and in the glossy press, sometimes we forget how early ACIC published the final version of the Lunar Reference Mosaic, or LEM-1 (Lunar Earthside Mosaic). It had a diameter of 27 inches at both 1:500,000 scale and 1:10,000,000 (LEM 1-A). The ACIC, led by cartographer Howard Holmes, produced the LEM and worked to update the product in three different scales in 1962 when more precise imagery became available. As a direct result of the LEM effort, ACIC became involved with NASA in the autumn of 1959, a full decade before the moon landing of Apollo 11, to support both the planned Mercury Program and more ambitious lunar mapping requirements.

As the ACIC developed the LEM, it worked simultaneously on the Lunar Astronautical Chart (LAC) in an effort to combine all of the imagery and data available into the best possible guide to the moon's surface. ACIC adopted a 1:1,000,000 scale, or 16 miles to the inch, because this method conformed to both the best image resolution available from then-current cameras and a particular set of Air Force charts published under the series title, World Aeronautical Chart.

Howard Holmes, Jerry Higgins and Charles Moore began work on the project in October 1959, dividing the moon into 144 areas of 22-by-29 inches each. Many of the shapes and dimensions attributed to lunar surface features relied heavily on shadow measurements and data taken at the time of image exposure. The actual charts appeared in two projections, Mercator and Lambert Conformal Conic, with the planned third, a polar stereoscopic, never actually going to press. Each chart carried the name of the most



The array of photographs offered here portray the entire spectrum of the lunar mapping experience from assembling spacecraft imagery photo mosaics, to data collection and confirmation via telescope, to collaborative efforts with observatories like Pic du Midi in France.

NGA Historical Research Center



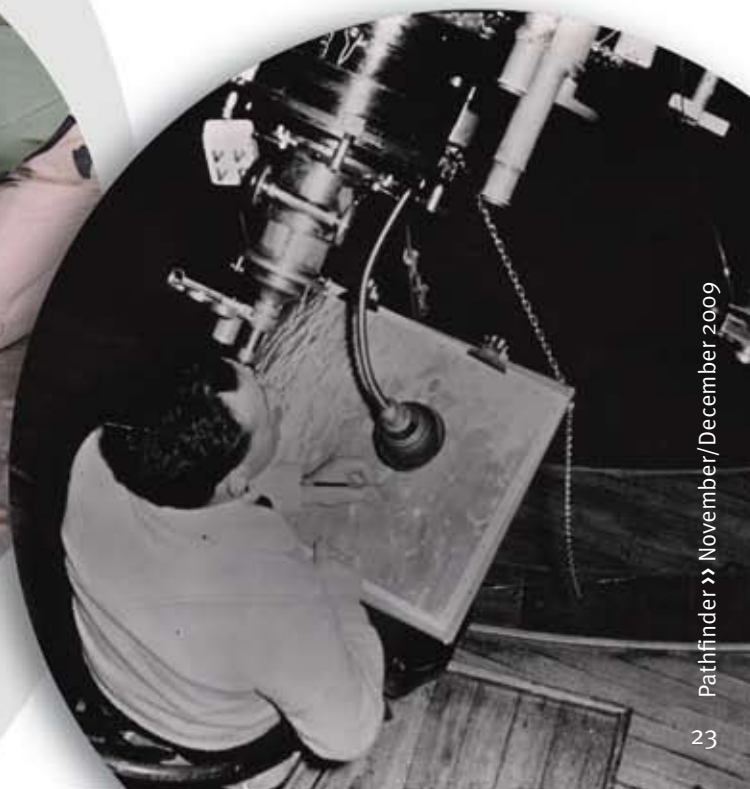
prominent feature available or that of a pioneer in space science. Thus, names such as Kepler (LAC-57), Copernicus (LAC-58) and Mare Vaporum (LAC-59) appeared in the series.

The first of these charts to emerge from the press, LAC-58, appeared in February 1960 with the cardinal directions set according to standard terrestrial cartographic norms. This flew in the face of the 18th and 19th century practice that placed south at the top of the compass rose reflecting the inverted image of the moon provided by optical sets of that era used in northern hemisphere telescopes. ACIC also established an official Air Force Observation Unit at the Lowell Observatory in Flagstaff, Ariz., to keep pace with the best and highest-resolution telescopic imagery available. At one point in the mid-1960s, ACIC also entered into a relationship with the University of Manchester in the United Kingdom to establish a lunar photographic program at the Pic du Midi Observatory. ACIC supplied an Air Force K-22 camera suitable for work with the French observatory's 24-inch refractor. This provided approximately 60,000 time-lapse photos from 1961 through 1966. Every 9-inch roll of film was returned to ACIC in St. Louis, Mo., for processing. In June 1961, ACIC published with the University of Chicago Press a lunar atlas, now in NGA's historical collection, based upon the 144 charts of the LAC.

In a more ambitious effort, ACIC produced the first 16-inch NASA Lunar Globe, also part of NGA's collection. Howard Holmes designed the globe at 1:8,533,150 scale. The 30-degree section drawings for the globe came from the pen of scientific illustrator Jay Inge working at the ACIC office at the Lowell Observatory. Inge rendered the far side of the moon by using photographs from the Lunar Orbiter satellite program that began in 1966. Earth-side particulars came from LAC renderings and telescope photographs. All features appeared on the globe as if captured from a spacecraft approaching the moon in a morning descent.

Like the work of Amerigo Vespucci, these maps made the next step possible, and all of this lunar mapping work supported the planned Apollo program journeys to the moon. As with our first maps of the new world in the 15th century or the first detailed map of the ocean bottom by Bruce Heezen and Marie Tharp in 1977, we always remember the first time a cartographer reveals the unseen, makes it understandable and permits all of us with a sense of adventure to take the next step. ACIC, one of NGA's predecessor agencies, gave us the moon and showed us the way. ♣

Dr. Gary E. Weir is the NGA Historian.



NEW CAMPUS EAST

Future Home of GEOINT Incorporates Green Technology

BY LOU BRUNE

The design and ongoing construction of NGA's New Campus East (NCE) near Springfield, Va., is transforming how geospatial intelligence (GEOINT) will inform the nation's leaders and warfighters. Once completed, GEOINT's new state-of-the-art home will provide critical operational support and foster collaboration among NGA employees and other Intelligence Community components. The campus design features emerging technologies to ensure that NGA contributes the best GEOINT possible in a green, environmentally friendly facility.

"The design and construction of the New Campus East project incorporates energy-efficient and environmentally responsible initiatives in each of the buildings and site infrastructure," states the U.S. Army Corps of Engineers resident engineer for NCE. Most of the strategies being incorporated are well-known, such as a green roof and the use of sustainable materials. However, the project also includes technologies that have only recently begun to be incorporated into projects in the United States.

The agency plans to submit the NCE design to the nonprofit U.S. Green Building Council and anticipates achieving the council's Leadership in Energy and Environmental Design (LEED) Silver certification. Certification recognizes construction that takes advantage of innovative technologies. The LEED for New Construction rating system guides and distinguishes high-performance buildings that have less of an impact on the environment and are healthier for those who work or live in them than conventional buildings. Projects earn points for addressing specific environmental impacts inherent in the design, construction, operations and management of a building.

NCE's chief electrical engineer notes, "NGA is on the forefront with its green building initiatives, incorporating innovative technologies, such as chilled beam construction and an ETFE [ethylene tetrafluoroethylene] transparent roofing system. In addition to creating a much more comfortable work environment for the employees, these technologies conserve energy usage in a much more efficient way."

One strategy benefiting the budget and the environment is the ETFE roof, the same technology used on the Water Cube designed for the 2008 Summer Olympics. NCE's main eight-story office building will include a 50,000-square-foot central atrium covered by an ETFE skylight.

Compared to glass, ETFE plastic weighs 99 percent less, transmits more light, and can cost up to 70 percent less to install. It is also more resilient, able to bear 400 times its weight, self-cleaning (due to its nonstick surface) and recyclable. Significantly less structural material is needed to support it because of the lighter weight. Moreover, solar shading can be adjusted by varying the air pressure between its layers.

Another key technology, chilled beams, is being installed in the main office building. These overhead panels efficiently adjust air temperature using chilled water to absorb heat rapidly. The system also induces fresh air into the building, but only what is required for ventilation, reducing the need for air conditioning and consequently the overall energy use. Other NCE buildings will use different green strategies for cooling. For example, lower-temperature chilled water will efficiently cool the Technology Center.

Additional ways that NCE is going green include:

- » Reusing rainwater for irrigation
- » Designing water-efficient landscaping
- » Recycling construction debris
- » Using low-emitting paints, coatings and carpets to improve indoor air quality
- » Installing high-efficiency mechanical and electrical components

NCE's environmentally friendly design stresses what NGA Director Vice Adm. Robert B. Murrett likes to call the "human element" of technology—focused on providing an environment and tools that make the analysts' jobs easier. NGA is doing just that by constructing a unified campus of environmental and analytical excellence. ▢

Lou Brune is a public affairs officer assigned to the New Campus East Program Management Office.

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Great Places to Work

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by *Washingtonian* magazine

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The November 2009 issue of the *Washingtonian* magazine, which focused on “Great Places to Work,” highlighted NGA as one of five featured government agencies. NGA was identified by employees as a place where the “pay, mission, culture,

flexibility, and benefits were the best parts of working at their agency.” The magazine touts NGA as a good choice for government employment.

Congratulations to NGA employees for making this such a great place to work!



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